OPERATING INSTRUCTIONS

MODEL TTS 25B

GENERAL PURPOSE PULSE
AND
TRANSMISSION MEASURING SET

Stop's

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GENERAL PURPOSE PULSE AND TRANSMISSION MEASURING SET

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Issued January 1967
Printed in U.S.A.

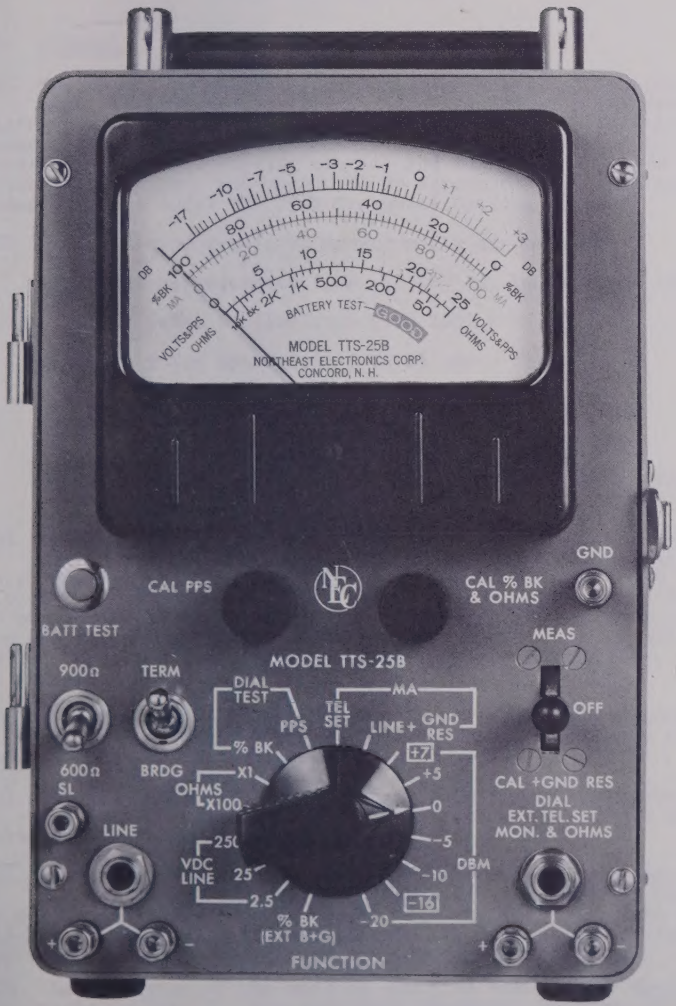
MODEL TTS-25B
NORTHEAST ELECTRONICS CORP.
CONCORD, N. H.
BATTERY TEST
GOOD
DB
%BK
MA
VOLTS&PPS
OHMS
CAL PPS
CAL % BK & OHMS
GND
BATT TEST
MEAS
MODEL TTS-25B
900Ω
TERM
600Ω
SL
BRDG
DIAL TEST
PPS
% BK
OHMS X1
X100
TEL SET
MA
LINE+
GND RES
+7
+5
0
-5
-10
-16
DBM
-20
OFF
CAL +GND RES
DIAL
EXT. TEL. SET
MON. & OHMS
LINE
VDC LINE
25
2.5
% BK (EXT B+G)
FUNCTION

FIG.-1

MODEL TTS 25B
GENERAL PURPOSE PULSE AND TRANSMISSION MEASURING SET

OPERATING INSTRUCTIONS

1.0 GENERAL

1.01 The Model TTS 25B is a compact, transistorized, general purpose measuring set designed for transmission measurements, dial pulsing tests, DC voltage and current measurements, and resistance checks. In addition to its general purpose applications it is particularly useful for station testing and loop checking when used in conjunction with the NEC Model TTS 39 Reference Tone Generator equipped with a Model TTS 39XF Frequency Cycling Adapter.

1.02 The following ranges of measurements may be made:

a. Level measurements from +10 to -37 dbm in seven ranges.

b. Dial pulse % break from 0 to 100%.

c. Dial pulse speed from 0 to 25 pps.

d. DC current from 0 to 100 ma.

e. DC voltage from 0 to 250 volts in three ranges.

f. Resistance measurements in two ranges to 10,000 ohms and 1 megohm.

1.03 Level measurements may be made on 600 or 900 ohm circuits on either a terminated basis or a 20,000 ohm bridging basis. The frequency response is within ±0.1 db from 200 cps to 20 KC, and ±1.0 db from 100 cps to 75 KC. The resistors used for the 600 and 900 ohm terminations are also used to provide a DC path to hold the line under test. AC coupling is provided to the input amplifier of the set to prevent any damage from DC voltages on the line, up to 400 volts.

1.04 Two jacks, each in parallel with two metal binding posts, are provided for making connections to the set; a single binding post is connected to the sleeves of both jacks.

1.05 The TTS 25B is powered by internal batteries, accessible from the rear of the set by removing a back cover. Ten D size and one 45 volt battery are required.

1.06 The unit is contained in a gray finished aluminum case 6" w x 9" h x 7½" d. The weight of the unit is 8 pounds. Storage for cords is provided in the cover. Closing the cover will move the MEAS-CAL key switch to the OFF position to prevent unnecessary battery drain.

1.07 The face view of the unit is shown in Fig. 1, the overall schematic in Fig. 2. The amplifier schematic is shown in Fig. 3.

2.0 PERFORMANCE DATA

Meter

2.01 A 4½", 1 ma meter with the following scales is provided:

DB Scale: 0.2 db divisions from +3 to -3 db
0.5 db divisions from -3 to -10 db
1.0 db divisions from -10 to -17 db

% BRK Scale: 2% divisions from 0 to 100%

MA Scale: 2 ma divisions from 0 to 100 ma

VOLTS and PPS Scale: 1 pps divisions from 0 to 25 pps. Depending on the position of the FUNCTION switch, either .1 volt divisions from 0 to 2.5 vdc, 1 volt divisions from 0 to 25 vdc, or 10 volt divisions from 0 to 250 vdc.

NOTE: One additional mark is provided at 2.17 volts for testing wet cell batteries.

OHMS Scale: Depending on the position of the FUNCTION switch either 0 to 10,000 ohms or 0 to 1 megohm.

BATT TEST Scale: A green arc marked GOOD.

The meter can withstand a continuous 50% overload (150 ma).

Level Measuring

2.02 The level measuring performance and features are:

Range of Measurements: +10 dbm to -37 dbm

Frequency Response: Maximum variations from 1000 cps response; 70°F and +3 to -3 db reading on meter.

±0.1 db from 200 cps to 20 KC
±.25 db from 150 cps to 50 KC
±1.0 db from 100 cps to 75 KC

Calibration: An internal calibration control is provided to set the meter at 0 db when an accurate 0 dbm signal is applied to the LINE jack.

Stability of Calibration: Changes referred to measurements at 70°F on representative set.

Temperature Errors: Typical performance at 0 db on meter, 50 to 120°F, ±0.1 db; 30 to 120°F, ±.25 db.

Supply Voltage Errors: Typical performance at 0 db on meter, ±0.1 db change from 15 volts to 12 volts.

Accuracy: ±0.1 db from +3 to -3 db on meter.

Attenuator Accuracy: Any position ±.1 db.

Input Impedance

Terminated: 600 ohms ±5% or 900 ohms ±5% at 1000 cps.

Bridging: 20,000 ohms for either 600 or 900 ohms bridging.

DC Blocking: AC coupling is provided to the input amplifier to prevent damage from DC voltages up to 400 vdc.

Holding Circuits: The resistors used for 600 and 900 ohm terminations provide a DC path to hold the line under test.

Receive on LINE Jack: A signal received on the LINE jack can be monitored on the EXT jack without affecting the accuracy of the readings.

Current Measuring

2.03 The current measuring performance and features are:

Range of Measurements: 0 - 100 ma

Impedance: 10 ohms across terminals in the LINE MA position of FUNCTION switch. 10 ohms in series with the circuit connected to the EXT TEL SET terminals when the FUNCTION switch is in the TEL SET MA position.

Accuracy: ±2% of full scale.

Ground Resistance Measuring

2.04 Accurate ground resistance measurements can be made up to 5000 ohms.

Dial Test

2.05 The dial test performance and features are:

PPS

Range of Measurements: 0 - 25 pps.

Calibration: Calibration control is provided.

Meter Response: The response of the meter is fast enough to permit accurate readings when the digit 9 is dialed on a 10 pps dial.

% Break

Range of Measurements: 0 - 100%

Calibration: A calibration control is provided.

The presence of spark suppression circuits such as 1 mfd and 100 ohms on a dial circuit causes an error of about 1% in the % break measurements.

Resistance Measuring

2.06 The performance and features are:

X 1 Ohms

Range of Measurements: 0 to 10,000 ohms.

Calibration: A calibration control is provided.

X 100 Ohms

Range of Measurements: 0 to 1 megohm.

Calibration: A calibration control is provided.

DC Voltage Measuring

2.07 The DC voltage measuring performance and features are:

Three Ranges: 0 - 2.5
0 - 25
0 - 250

Impedance: 1000 ohms per volt.

Accuracy: ±2% of full scale.

% BRK (EXT B&G)

2.08 Range of Measurements: 0 - 100%.

Calibration: A calibration control is provided.

3.0 CIRCUIT DESCRIPTION

3.01 The Model TTS 25B Transmission Test Set contains a transistorized amplifier designed to drive the meter for all level measurements. In addition, it provides through connection from the LINE jack to the TEL SET jack, and it contains DC voltage resistance, current, and dial test measuring provisions. The front panel view of the set is shown in Fig. 1.

Level Measuring Circuit

3.02 In all level measuring positions of the FUNCTION switch the LINE jack is connected to a voltage divider attenuator, the output of which is connected to the input of the transistor amplifier. This circuit arrangement is shown in the overall schematic, Fig. 2.

3.03 The amplifier is a conventional transistor amplifier in which the rectifier bridge supplying the meter is inserted in the feedback path. Specially selected components as well as the use of negative feedback provide gain stability with variations in temperature and battery voltage. The amplifier schematic is shown in Fig. 3.

3.04 The amplifier has sufficient gain to provide a 0 dbm meter reading with an input signal of -20 dbm. The meter scale is calibrated from +3 to -17 db. As a result, levels of -37 dbm can be read in the most sensitive position of the attenuator.

3.05 A 600-900 ohm impedance switch is provided to enable direct reading on either 600 or 900 ohm circuits and a BRDG-TERM switch is provided to enable either bridging measurements or terminated measurements. The BRDG-TERM switch, when in the TERM position, provides a DC holding circuit through the 600 or 900 ohm resistor. No holding circuit is provided when the set is used for bridging measurements.

DC Voltage

3.06 The DC voltage measuring circuits are conventional in design, and Fig. 2 should be self-explanatory.

DC Current Measuring Circuits

Line MA

3.07 When the FUNCTION switch is in the LINE MA position, a 10 ohm current measuring circuit is connected across the tip and ring of the line circuit, thereby indicating short circuit line current.

Tel Set MA

3.08 The FUNCTION switch, when in the TEL SET MA position, connects

the LINE jack through to the TEL SET jack and connects a 10 ohm current measuring circuit in series with the telephone set. The total circuit current through the telephone set can be read directly on the TTS 25B meter.

Ground Resistance

3.09 Provisions are made to measure ground resistance between the subscriber location and the central office. This is accomplished by measuring first the short circuit line current and then measuring the current from the negative side of the line through a 200 ohm resistor to the subscriber ground. Fig. 4 illustrates the method of measurements. By knowing these two current measurements, the ground resistance between the subscriber location and the central office can be extrapolated from the graph in the cover of the set or in Fig. 5 of the manual.

3.10 Theory of Operation. To make ground resistance measurements, the line loop resistance must be known, and it must be assumed that the loop resistance is equally divided in the two sides of the line. Assuming the central office battery to be 50 volts, and being able to measure the line current, we can determine the loop resistance, (R_L). Knowing one half of R_L, the ground resistance (R_G) can be determined by a current measurement through one half of the A relay, one half of the loop resistance, a 200 ohm resistance to ground, and through the ground resistance back to the central office.

3.11 Example A

At a subscriber location a line current of 60 ma is recorded, and a ground current of 81 ma is recorded.

The total loop resistance is:

$$\frac{E}{I_L} = \frac{50}{60} = 833 \text{ ohms}$$

The loop resistance less the A relay is:

$$R_L = 833 - 400 = 433 \text{ ohms}$$

The ground resistance is:

$$\frac{E}{I_G} - (400 + \tfrac{1}{2} R_L) = \frac{50}{81} - (400 + 216.6)$$

$$= 616.6 - 616.6$$

$$R_G = 0 \text{ ohms}$$

3.12 Example B

At a subscriber location a line current of 85 ma is recorded, and a ground current of 50 ma is recorded.

The total loop resistance is:

$$\frac{E}{I_L} = \frac{50}{85} = 589 \text{ ohms}$$

The loop resistance less the A relay is:

$$R_L = 589 - 400 = 189 \text{ ohms}$$

The ground resistance is:

$$\frac{E}{I_G} - (400 + \tfrac{1}{2} R_L) = \frac{50}{50} - (400 + 94.5)$$

$$= 1000 - 494.5$$

$$R_G = 505.5 \text{ ohms}$$

Dial Test

Pulses Per Second

3.13 The TTS 25B contains a dial pulse speed measuring circuit to enable dial speed measurement of a subscriber's phone. The circuit operates from batteries contained within the TTS 25B.

3.14 Pulses applied to the EXT TEL SET jack or terminals operate relay K1, which in turn charges an integrator circuit with a voltage proportional to the speed of the pulses. This voltage is applied across the meter circuit which indicates the pulse speed. A CAL position is provided on the CAL/MEAS switch, and a CAL PPS control is provided to enable calibration of the circuit with aging batteries.

Per Cent Break

3.15 The set contains a circuit to provide % break measurements on a subscriber telephone dial. The circuit operates from batteries contained within the TTS 25B.

3.16 The circuit contains the proper RC time constant damping to enable correct readings in % break when the digit "0" is dialed on an external dial. Internal calibration circuits are established when the CAL/MEAS switch is moved to CAL and a front panel CAL % BREAK control is provided to enable calibration of the circuit with aging batteries.

% Break External Battery and Ground

3.17 The FUNCTION switch position designated % BK (EXT B&G) enables % break measurements on E and M leads. The circuit contains the proper RC time constant damping circuits to enable reading in % break when the digit "0" is dialed.

Ohms

3.18 Two resistance measuring ranges are provided in the TTS 25B. Conventional circuit designs are used for both ranges. See Fig. 2.

Battery Test

3.19 A BATT TEST push button is provided which, when depressed, transfers the + side of the meter from its normal measuring circuit to a circuit for measuring the internal battery voltage.

4.0 CONTROLS, SWITCHES, JACKS, AND TERMINALS

4.01 FUNCTION Switch

The FUNCTION switch enables selection of the various functions performed by the TTS 25B

4.02 CAL/MEAS Key Switch

The CAL/MEAS key switch prepares the set for calibration or measurement of external signals and disconnects the internal batteries when in the OFF position.

4.03 600/900 OHM Impedance Switch

The impedance switch matches the internal level measuring circuits to either a 600 or 900 ohm circuit under test.

4.04 BRDG/TERM Switch

The BRDG/TERM switch prepares the level measuring circuits for either bridging or terminating measurements.

4.05 BATT TEST Push Button

The BATT TEST push button enables an immediate check on the condition of the internal batteries. The batteries should be replaced when the meter reading is below the green BATT TEST arc.

4.06 CAL PPS Control

The CAL PPS control provides a calibration adjustment to compensate for changes in battery voltage.

4.07 CAL % BRK and OHMS

The CAL % BRK and OHMS control provides a calibration adjustment for the two % break ranges and the two ohm meter ranges to compensate for changes in battery voltage.

4.08 LINE Jack and Terminals

The LINE jack provides for connection of the line circuit to the TTS 25B for measurements of level, DC current, DC voltages, and % break measurements. The terminals are tied in parallel with the tip and ring of the jack.

4.09 DIAL - EXT TEL SET - MON & OHMS Jack and Terminals

This jack provides for connection of external station equipment to the TTS 25B for purposes of dialing through the test set

and measuring Tel Set current. This jack also provides a monitoring feature while measuring level on the line and provides access for the OHMS measuring circuits.

4.10 SL Terminal The SL terminal is connected to the sleeve of both the LINE and TEL SET jacks.

4.11 GND Terminal

The GND terminal provides for connection of station ground to the TTS 25B.

5.0 CALIBRATION

Level Measuring Circuits Calibration

5.01 The TTS 25B level measuring circuits are accurately calibrated at the factory and the internal calibrate control is sealed to prevent it from changing due to vibration of handling and shipping. It may be necessary to recheck calibration periodically, depending on conditions of use, against an accurately calibrated 1 KC 0 dbm signal standard.

5.02 To calibrate the level measuring circuits, proceed as follows:

5.03 Move the FUNCTION switch to the 0 dbm position, move the CAL/MEAS switch to MEAS, move the TERM/BRDG switch to TERM, and move the 600/900 ohm impedance switch to the proper position to match the impedance of the standard signal generator.

5.04 Depress the BATT TEST push button and insure that the batteries are in satisfactory condition. If the batteries are not satisfactory, replace all batteries.

5.05 Connect the output of the signal generator to the LINE jack and observe the meter reading on the TTS 25B. If the meter does not read 0 dbm, remove the TTS 25B from its case and readjust R38 until the meter does read 0 dbm. The control should then be resealed with glyptol and the set reinstalled in its case.

Dial Test % Break Measuring Circuits Calibration

5.06 Measurements can be performed on an external dial Tel Set connected to the EXT TEL SET terminals. The calibration of the measuring circuits is as follows:

5.07 With the FUNCTION switch in the DIAL TEST % BRK position, move the CAL/MEAS switch to the MEAS position. Remove the hand set of the telephone from its cradle and adjust the CAL % BRK control until the meter reads 0% break. The DIAL TEST % BRK measuring circuit is now calibrated.

% Break (EXT B&G) Calibration

5.08 Place the FUNCTION switch in the % BRK (EXT B&G) position.

To Measure Ground and Open Pulses on the E Lead

5.09 Insert the plug of a W2C cord (tip-ring, two conductor cord with 310 plug at one end and alligator clips on the other) into the LINE jack. Clip the tip lead to the E lead under test and the ring lead to the 48 volt central office battery.

5.10 Place the MEAS key in the MEAS position.

5.11 Place the circuit under test in an OFF HOOK condition and adjust the CAL % BRK and OHMS potentiometer for 0% break.

5.12 The TTS 25B is now set up to measure the % break of ground and open pulses on the E lead.

To Measure Battery and Ground (or open) Pulses on the M Lead

5.13 Insert the plug of a W2C cord (same as in 5.09 above) into the LINE jack. Clip the ring lead to the M lead under test and the tip lead to ground.

5.14 Place the MEAS key to the MEAS position.

5.15 Place the circuit under test in an OFF HOOK condition and adjust the CAL % BRK and OHMS potentiometer for 0% break.

5.16 The TTS 25B is now set up to measure the % break of battery and ground (or open) pulses on the M lead.

Dial Test Pulses Per Second Calibration

5.17 With the FUNCTION switch in the DIAL TEST PPS position, move the CAL/MEAS switch to the CAL position, provide an OFF HOOK condition across the EXT TEL SET terminals and adjust the CAL PPS control until the meter reads 25 pps.

5.18 The set is now calibrated for measurement of pps from an external dial connected to the EXT TEL SET terminals or jack.

Ohm Calibration

5.19 Move the FUNCTION switch to the OHMS range to be used, move the CAL/MEAS key switch to MEAS. Momentarily provide a short circuit on the EXT TEL SET terminals while adjusting the CAL % BRK and OHMS control until the meter reads 0 ohms.

5.20 The OHMS measuring circuit is now calibrated for use.

NOTE: When switching to a different ohms range on the FUNCTION switch, recalibration is necessary.

6.0 OPERATION

6.01 CAUTION: PRIOR TO CONNECTING THE TTS 25B TO ANY CIRCUIT TO BE TESTED, PLACE THE FUNCTION SWITCH IN THE PROPER POSITION FOR THE TEST TO BE PERFORMED. OTHERWISE DAMAGE MAY RESULT TO THE INTERNAL CIRCUITS OF THE TTS 25B.

Initial Steps

6.02 a. Unlatch and open the cover. The cover can be detached from the case by sliding the cover up toward the handle end of the case. When measurements are completed, it is recommended that the cover be attached and closed, as a bracket on the cover will insure that the MEAS/CAL key switch is in the OFF position when the cover is closed.

b. Connect the line to the LINE jack or binding posts, connect a telephone set to the EXT TEL SET jack or binding posts and connect a lead from a station ground to the GND binding post.

To make Level Measurements

6.03 a. Place the FUNCTION switch in the +7 dbm position, select the proper impedance to match the line and move the BRDG/TERM switch to the desired position.

b. Use the dial of the telephone set connected to the EXT TEL SET jack to dial the number of the central office milliwatt generator.

c. After the connection has been established, move the MEAS/CAL key switch to the MEAS position.

d. Move the FUNCTION switch to a position which provides a reading between +3 and -3 on the meter. The measured level is the algebraic sum of the meter reading and the designated position of the FUNCTION switch.

To Measure TEL SET or LINE Current

6.04 a. Move the FUNCTION switch to the TEL SET MA position and move the MEAS/CAL key switch to the MEAS position. If the meter reading is reversed, reverse the leads connected to the LINE terminals.

The current flowing through the telephone set can now be read directly on the red MA scale.

b. Move the FUNCTION switch the LINE MA + GND RES position and place the MEAS/CAL key switch in the MEAS position.

The short circuit line current can be read directly on the meter. (The impedance of the current measuring circuit is 10 ohms.)

To Measure Ground Resistance.

6.05 a. Note the line current observed in section 6.04b above.

b. Move the MEAS/CAL key switch to the CAL + GND RES position and note the ground resistance current measurement.

c. Locate the two currents on the graph in the cover of the test set. The two currents converge at a point on the graph indicating ground resistance.

d. Examples:

1. Line current 60 ma

Ground current 80 ma

Ground resistance = 0 ohms

2. Line current 40 ma

Ground current 18 ma

Ground resistance = approximately 2000 ohms.

To Measure DIAL TEST PPS

6.06 a. Connect the telephone set to EXT TEL SET terminals. Do not connect the line to the LINE terminals.

b. Move the FUNCTION switch to the PPS position and provide an OFF HOOK condition to the EXT TEL SET terminals. Move the MEAS/CAL key switch to the CAL position and adjust the CAL PPS for a reading of 25 pps.

c. Move the MEAS/CAL key switch to the MEAS position and dial the digit "0" with the external tel set. The pulses per second can be read directly on the VOLTS and PPS scale.

To Measure DIAL TEST % BREAK

6.07 a. Connect the telephone set to the EXT TEL SET jack. Do not connect the line to the LINE terminals.

b. Move the FUNCTION switch to the DIAL TEST % BRK position. Move the MEAS/CAL key switch to the MEAS position and adjust the CAL % BRK for a reading of 0% break with the telephone set in the OFF HOOK condition.

c. Dial the digit "0" with the external Tel Set. The % break of the dial can be read directly on the % BRK scale.

To Measure OHMS

6.08 a. Select the desired range on the FUNCTION switch and move the MEAS/CAL switch to the MEAS position.

b. Connect the test leads to the DIAL - EXT TEL SET - MON and OHMS terminals. Short the test leads together while adjusting the CAL % BRK and OHMS control for a reading of 0 ohms.

c. Resistance measurements can now be made with the test leads.

d. NOTE: Recalibration is necessary when switching from one ohms range to another.

To Measure DC Volts

6.09 a. Move the FUNCTION switch to the 250 VDC range, move the MEAS/CAL key switch to the MEAS position and connect the test leads to the LINE terminals.

b. DC volts are read on the VOLTS AND PPS scale.

c. Set FUNCTION switch to the VDC position, which will give a convenient meter reading.

To Measure the % Break of Ground and Open Pulses on E Lead

6.10 Place the FUNCTION switch in the % BRK (EXT B&G) position.

6.11 Insert the plug of a W2C cord (tip-ring, two conductor cord with 310 plug at one end and alligator clips on the other) into the LINE jack. Clip the tip lead to the E lead under test and the ring lead to the 48 volt central office battery.

6.12 Place the MEAS key switch in the MEAS position.

6.13 Place the circuit under test in an OFF HOOK condition and adjust the CAL % BRK and OHMS potentiometer for 0% break.

6.14 The TTS 25B is now set up to measure the % break of ground and open pulses on the E lead.

To Measure the % Break of Battery and Ground (or open) Pulses on the M Lead

6.15 Place the FUNCTION switch in the % BRK (EXT B&G) position.

6.16 Insert the plug of a W2C cord (same cord as in Section 6.11) into the LINE jack. Clip the ring lead to the M lead under test and the tip lead to ground.

6.17 Place the MEAS key to the MEAS position.

6.18 Place the circuit under test in an OFF HOOK condition and adjust the CAL % BRK and OHMS potentiometer for 0% break.

6.19 The TTS 25B is now set up to measure the % break of battery and ground (or open) pulses on the M lead.

7.0 MAINTENANCE

7.01 No routine maintenance is necessary on the TTS 25B except a periodic check of the condition of the batteries and an occasional check of the level measuring calibration with a 1 Kc, 0 dbm signal standard as described in Section 5.0.

7.02 To check the internal D cell batteries, move the MEAS/CAL key switch to MEAS and depress the BATT TEST push button. The D cell batteries should be replaced when the meter reads below the green battery test arc.

7.03 The 45 volt battery used in the high ohms circuit should be replaced whenever the OHMS X100 range cannot be calibrated.

7.04 All batteries can be replaced by removing the rear cover of the set.

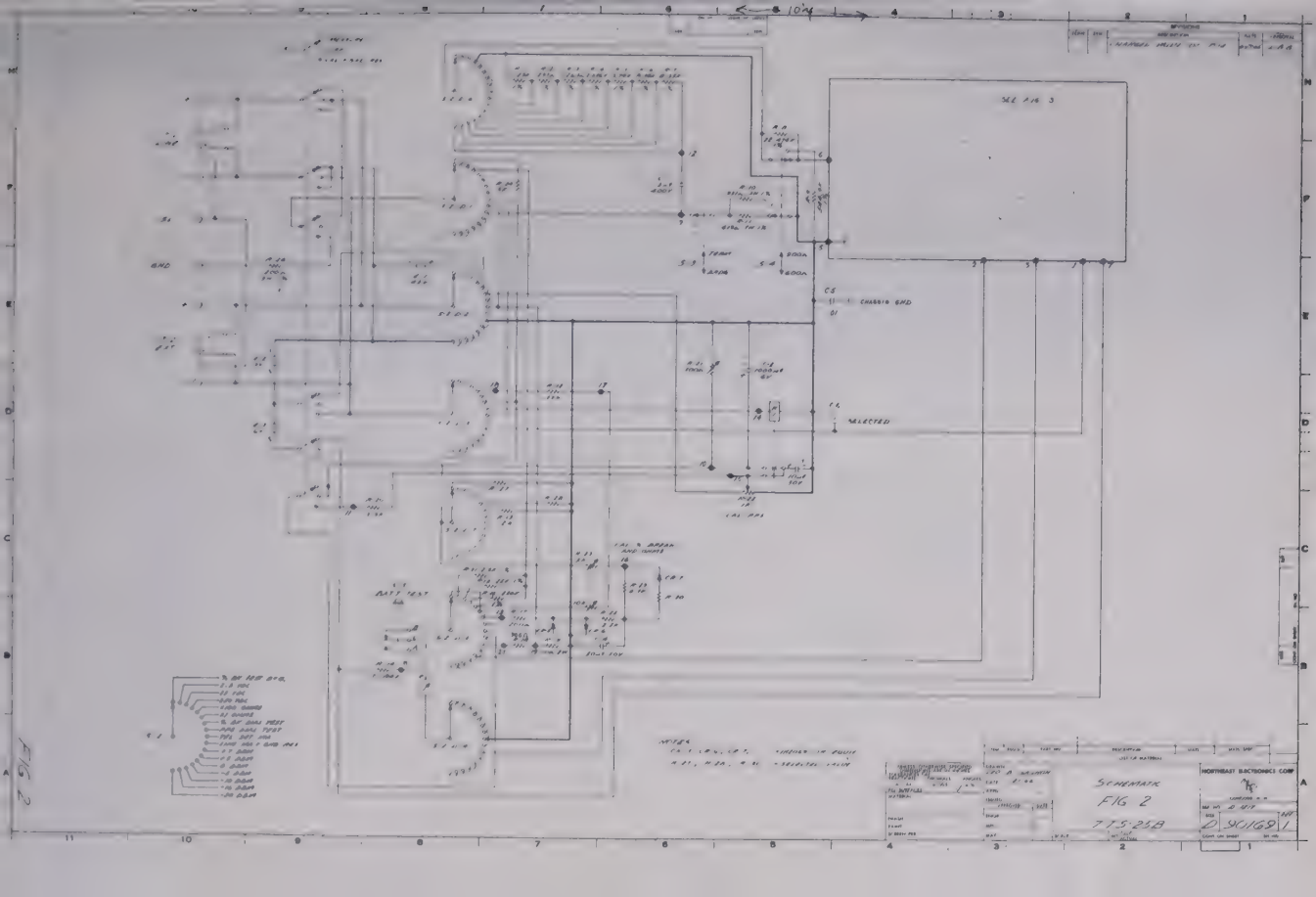
SEE FIG 3
CHASSIS GND
SELECTED
SCHEMATIC
FIG 2
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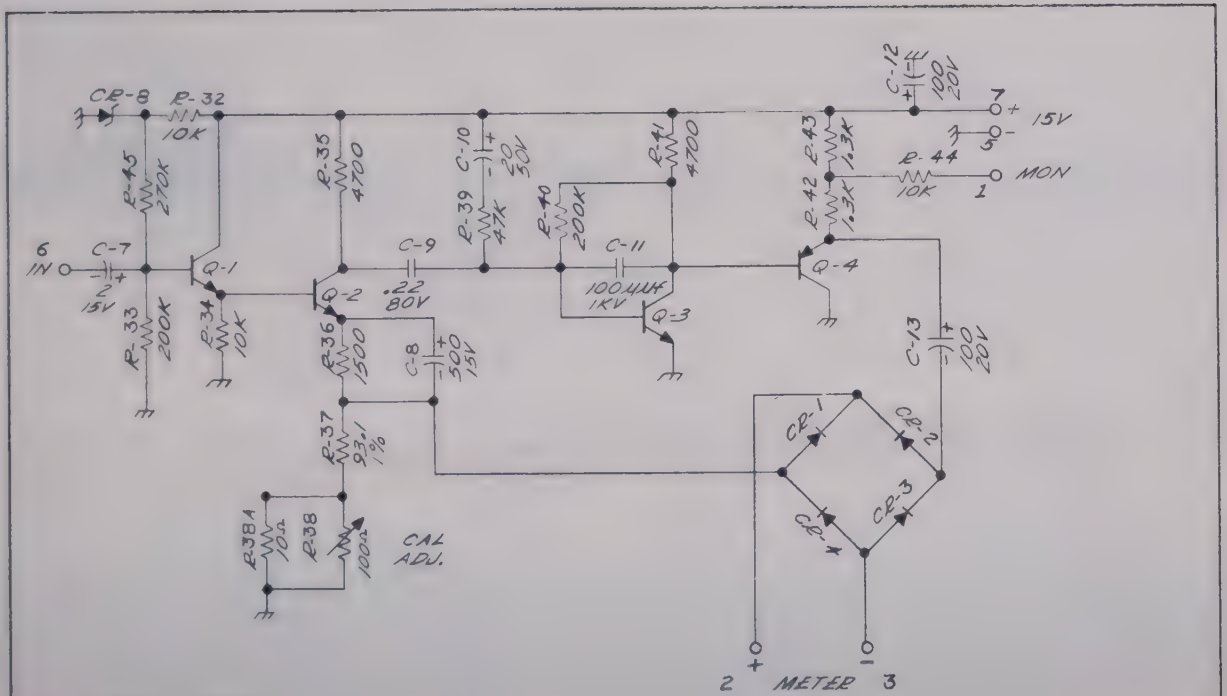
FIG 2



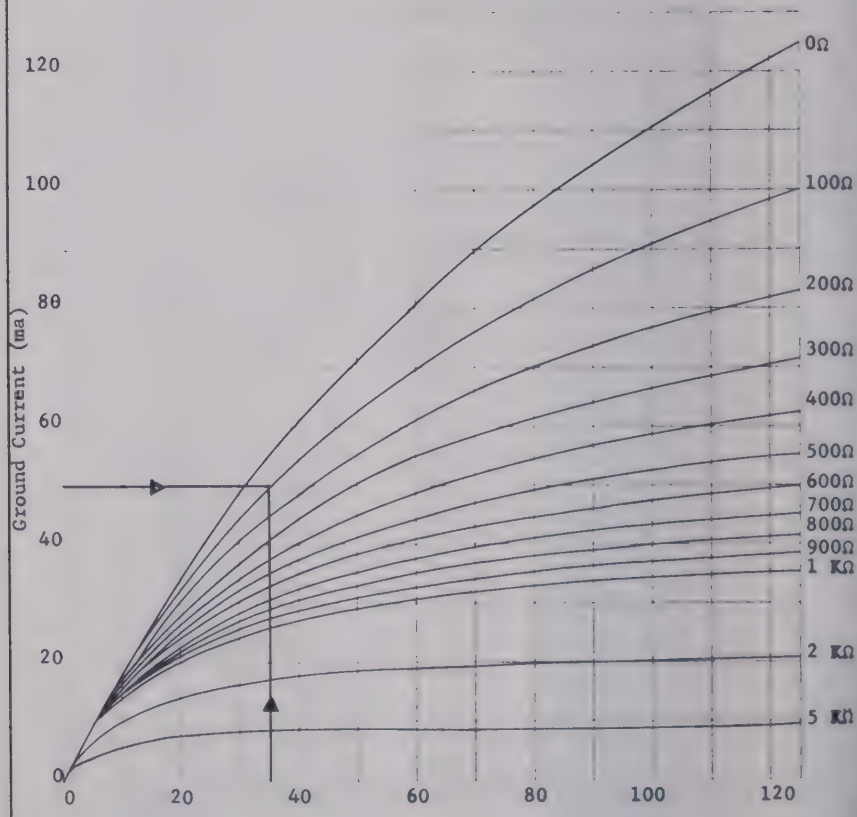
CR-1 = IN764
CR-2 THRU CR-5 = IN198
Q-1 THRU Q-3 = 2N2102
Q-4 = 2N3638
ALL CAPS IN μF UNLESS NOTED

FIG-3

AMPLIFIER
SCHEMATIC
TTS 25B

FIG. 4

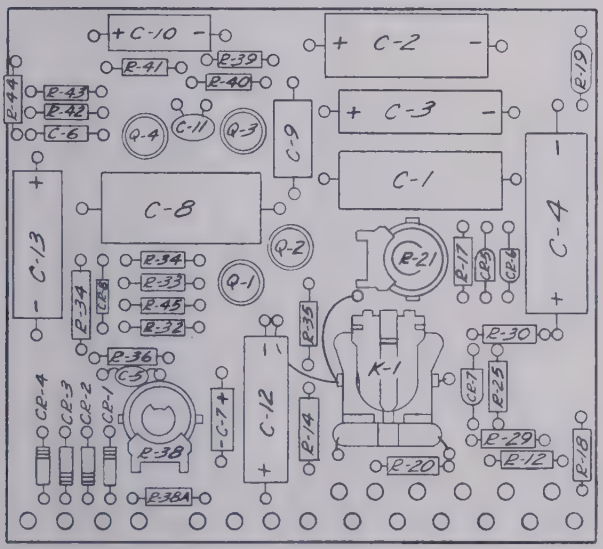
GROUND RESISTANCE MEASUREMENTS



The above example has 35ma Line Current and 50ma Ground Current which indicates 100 ohms of ground resistance.

TTS 25B
Ground Resistance Curves

Fig.5



MODEL TTS-25B
PRINTED CIRCUIT BD.
ASSEMBLY

FIG-6

TABLE OF REPLACEABLE PARTS

Circuit Ref	Description	Mfr* & Mfr's Designation
C1	Capacitor: fixed, paper, .5 mfd, 400 vdc	A, P8292ZN21
C2	Capacitor: fixed, electrolytic, 1000 mfd, 6 vdc	H, APD-122
C3	Capacitor: fixed, electrolytic, 10 mfd, 50 vdc	Q, TVA-1304
C4	Capacitor: fixed, electrolytic, 50 mfd, 50 vdc	Q, TVA-1308
C5	Capacitor: fixed, disc, .01 mfd, 600 vdc	D, ID-01
C6	Capacitor: fixed, selected value	
C7	Capacitor: fixed, electrolytic, 2 mfd, 15 vdc	Q, TE1149
C8	Capacitor: fixed, electrolytic, 500 mfd, 15 vdc	H, APD-124-0
C9	Capacitor: fixed, paper, .22 mfd, 80 vdc	Q, 192P
C10	Capacitor: fixed, electrolytic, 20 mfd, 50 vdc	Q, TE1305
C11	Capacitor: fixed, disc, 100 mmfd, 1 kvdc	D, DD-101
C12	Capacitor: fixed, electrolytic, 100 mfd, 20 vdc	H, APD-095
C13	Capacitor: fixed, electrolytic, 100 mfd, 20 vdc	H, APD-095
R1	Resistor: fixed, metal film, 1.129 K ±1%, ½ w	I, CEC-TO
R2	Resistor: fixed, metal film 297 ohms ±1%, ½ w	I, CEC-TO
R3	Resistor: fixed, metal film, 1126.7 ohms ±1%, ½ w	I, CEC-TO
R4	Resistor: fixed, metal film, 2056 ohms ±1%, ½ w	I, CEC-TO
R5	Resistor: fixed, metal film, 3.74 K ±1%, ½ w	I, CEC-TO
R6	Resistor: fixed, metal film, 8.30 K ±1%, ½ w	I, CEC-TO
R7	Resistor: fixed, metal film, 8.35 K ±1%, ½ w	I, CEC-TO
R8	Resistor: fixed, metal film, 22.474 K ±1%, ½ w	I, CEC-TO
R9	Resistor: fixed, metal film, 544.9 K ±1%, ½ w	I, CEC-TO
R10	Resistor: fixed, wirewound, 931 ohms ±1%, 3 w	B, RS-2
R11	Resistor: fixed, wirewound, 619 ohms ±1%, 7 w	B, RS-7
R12	Resistor: fixed, composition, 39 K ±5%, ½ w	B, EB3935
R13	Resistor: fixed, composition, 1.2 K ±5%, ½ w	B, EB1225
R14	Resistor: fixed, metal film, 17.094 K ±1%, ½ w	I, CEC-TO
R15	Resistor: fixed, metal film, 25 K ±1%, ½ w	I, CEC-TO
R16	Resistor: fixed, metal film, 250 K ±1%, ½ w	I, CEC-TO
R17	Resistor: fixed, composition, 200 ohms, ±5%, ½ w	B, EB2015
R18	Resistor: fixed, metal film, 900 ohms ±1%, ½ w	I, CEC-TO
R19	Resistor: fixed, wirewound, 10 ohms ±5%, 2 w	Q, 240E1001
R20	Resistor: fixed, composition, 3.9 K ±5%, ½ w	B, EB3925
R21	Resistor: variable, carbon, 500 ohms	J, MTC-4
R22	Resistor: variable, carbon, 1 K	D, HMS-1000
R23	Resistor: variable, dual, wirewound, 5K-10K	I, PQ-11-114M11-116
R24	Resistor: fixed, composition, 3 K ±5%, ½ w	B, EB 3025
R25	Resistor: fixed, composition, 2.2 K ±5%, ½ w	B, EB2225
R26	Resistor: fixed, wirewound, 200 ohms ±1%, 3 w	E, RS-2
R27	Resistor: selected value	
R28	Resistor: selected value	
R29	Resistor: fixed, composition, 4.7 K ±5%, ½ w	B, EB4725
R30	Resistor: selected value	
R31	Resistor: fixed, metal film, 2.5 K ±1%, ½ w	I, CEC-TO
R32	Resistor: fixed, composition, 10 K ±5%, ½ w	B, EB1035
R33	Resistor: fixed, composition, 200 K ±10%, ½ w	B, EB2741
R34	Resistor: fixed, composition, 10 K ±5%, ½ w	B, EB1035
R35	Resistor: fixed, composition, 4.7 K ±5%, ½ w	B, EB4725

TABLE OF REPLACEABLE PARTS

Circuit Ref	Description	Mfr* & Mfr's Designation
R36	Resistor: fixed, composition, 1.5 K ±5%, ½ w	B, EB1525
R37	Resistor: fixed, metal film, 93.1 ohms ±1%, ½ w	I, CEC-TO
R38	Resistor: variable, carbon, 100 ohms	J, MTC-4
R38A	Resistor: fixed, composition, 10 ohms ±10%, ½ w	B, EB1001
R39	Resistor: fixed, composition, 47 K ±10%, ½ w	B, EB4731
R40	Resistor: fixed, composition, 200 K ±5%, ½ w	B, EB2045
R41	Resistor: fixed, composition, 4.7 K ±5%, ½ w	B, EB4725
R42	Resistor: fixed, composition, 1.3 K ±5%, ½ w	B, EB1325
R43	Resistor: fixed, composition, 1.3 K ±5%, ½ w	B, EB1325
R44	Resistor: fixed, composition, 10 K ±5%, ½ w	B, EB1035
R45	Resistor: fixed, composition, 270 K ±5%, ± w	B, EB2745
CR1	Diode	T, 1N198
CR2	Diode	T, 1N198
CR3	Diode	T, 1N198
CR4	Diode	T, 1N198
CR5	Diode	T, 1N2069
CR6	Diode	T, 1N2069
CR7	Diode	T, 1N2069
CR8	Diode	U, 1N764
Q1	Transistor: NPN	N, 2N2102
Q2	Transistor: NPN	N, 2N2102
Q3	Transistor: NPN	N, 2N2102
Q4	Transistor: PNP	G, 2N3638
K1	Relay: RS5D, 2500 ohm coil, 6 volt	M, 503
E1	Battery: 45 volt	F, 415
E2-E3	Battery: 1.5 volt (10 required)	F, 950
S1	Switch: key	R, 172C
S2	Switch: rotary, 8 pole, 17 position (FUNCTION)	L, 253736-DL8
S3	Switch: toggle, SPST (TERM/BRDG)	C, 81015BP
S4	Switch: toggle DPDT (IMP)	C, 81027CH
S5	Switch: pushbutton (BATT TEST)	S, 903
J1	Jack: 310 type (LINE)	S, L-12B
J2	Jack: 310 type (EXT)	S, L-12B
BP1	Binding Post: brass, nickel plated (LINE)	P, 137-SP
BP2	Binding Post: brass, nickel plated (LINE)	P, 137-SP
BP3	Binding Post: brass, nickel plated (SL)	P, 317-SP
BP4	Binding Post: brass, nickel plated, (GND)	P, 137-SP
BP5	Binding Post: brass, nickel plated (EXT)	P, 137-SP
BP6	Binding Post: brass, nickel plated (EXT)	P, 137-SP
	Knob: for Switch S2	O, 70-8WL-2
	Knob: for R22 and R23	O, 70-1-2
	Meter: special	K, 25B-4383-00

*See List of Manufacturers Code Letters for Replaceable Parts Table

LIST OF MANUFACTURERS CODE LETTERS

Code Letter	Manufacturer
A	Aerovox Corporation
B	Allen-Bradley Company
C	Arrow-Hart and Hageman Electric Company
D	Centralab Electronics
E	Dale Electronics, Inc.
F	Eveready
G	Fairchild Semiconductor
H	International Electronic Industries, Inc.
I	IRC, Inc.
J	P. R. Mallory and Company
K	Northeast Electronics Corporation
L	Oak Manufacturing Company
M	Potter and Brumfield
N	Radio Corporation of America
O	Raytheon Company
P	H. H. Smith Company
Q	Sprague Electric Company
R	Stromberg-Carlson
S	Switchcraft, Inc.
T	Sylvania Electric Products, Inc.
U	Transitron

Notes

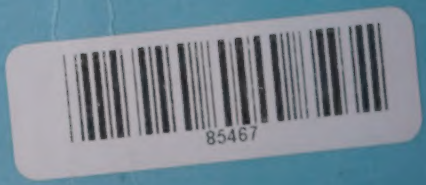
MODEL TTS 25B
ERRATA SHEET NO. 1

SECTION 5 CALIBRATION
Paragraph 5.17, page 5.2 should read:

With the FUNCTION switch in the DIAL TEST PPS position, move the CAL/MEAS switch to CAL. SHORT the EXT TEL SET terminals and adjust the CAL PPS control until the meter indicates 25pps. Remove short from EXT TEL SET terminals.

SECTION 6 OPERATION
Paragraph 6.06, subpara. b, page 6.2 should read:

Move the FUNCTION switch to the PPS position and SHORT the EXT TEL SET terminals. Move the MEAS/CAL switch to the CAL position and adjust the CAL PPS control for a meter indication of 25pps. Remove short from the EXT TEL SET terminals.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